COWLING ARRANGEMENT FOR A TURBOFAN ENGINE

BACKGROUND OF THE INVENTION

In general, this invention relates to a cowling arrangement for a turbofan engine and, more particularly, to a variable cowling arrangement for a turbofan engine having variable pitch fan blades wherein an increased airflow can be admitted to the fan for improved performance efficiency during the reverse pitch mode of fan operation.

The new family of high bypass, large diameter, turbofan engines recently introduced into airline service have proved to be an economical and convenient means of propulsion for today's wide bodied aircraft which cruise subsonically. The high bypass engines have also demonstrated noise levels which are significantly lower than those of previous generation engines due to the reduced jet velocities of the airflow pressurized by the fan, while thrust levels have been increased as a direct result of the increased mass airflow through the fan. Even further increases in performance efficiency could be obtained if the fan speed could be varied to meet different engine operating requirements as dictated by the flight mission.

One means of varying the fan speed of a bypass turbofan engine without changing the rotational speed of the core engine is through the use of variable pitch fan blading. Such blading may be varied to cater to varying flight conditions and may be varied to reverse pitch for complete thrust reversal after the aircraft has landed. One difficulty which arises when the variable pitch fan blades are in reverse pitch for braking is that the airflow which is drawn into the fan from the rear may suffer some degree of distortion due to the turning of the airflow into the core engine compressor which still requires an inlet airflow for continued operation of the core engine. This distortion is due to the fact that the reverse pitch airflow passing forwardly must turn **180°** in order to enter the core engine inlet. As a direct consequence of such distorted flow, there is an aerodynamic restricting, or nozzle effect, produced in the airflow before it reaches the variable pitch fan blades. Since the entry to the fan is so restricted, the reverse thrust produced by the variable pitch fan is less than it would otherwise be if this aerodynamic restriction could be eliminated or reduced.

One proposed solution to the aforementioned problem has involved the use of a two part cowling around the variable pitch fan wherein the aft portion of the cowling has the ability to slide axially rearwardly with respect to the main forward portion, thus providing an annular intake to increase the reverse airflow to the fan. However, not only is it desirable that the aft portion of the cowling be made translatable to accommodate an increased airflow during reverse pitch, but there must also be means for varying the exit area from the cowling during normal operation at forward pitch. This is necessary in order to accommodate for the variations in mass airflow through the fan during the various modes of flight operation such as takeoff, climb to altitude, cruise and descent from altitude.

Therefore it is a primary object of this invention to provide a cowling arrangement for a turbofan engine having variable pitch fan blades wherein an increased airflow can be provided to the fan during reverse pitch operation while the exit area from the fan cowling can

be varied during forward pitch operation to accommodate for the variations in mass airflow through the fan.

It is also an object of this invention to provide a cowling arrangement for a turbofan engine having variable pitch fan blades wherein the aft portion of the fan cowling has the ability both to slide axially with respect to the main forward portion providing an annular intake to increase reverse airflow, and to vary radially so as to adjust exit area during normal operation at forward pitch.

SUMMARY OF THE INVENTION

These and other objects and advantages will become clearly understood from the following detailed description and drawings, all of which are intended to be representative of, rather than in any way limiting on, the scope of invention. A turbofan engine of the variable pitch fan type is provided with a two part fan cowling comprising a forward fixed portion and an aft variable portion. The aft variable portion includes a unison ring translatably disposed in relation to the downstream end of the fixed portion wherein a plurality of circumferentially spaced apart nozzle flaps are rotatably disposed around the unison ring. An inflatable bladder is disposed within the unison ring with an actuating ring section translatably disposed between the bladder and nozzle flaps so that inflation of the bladder operates to translate the actuating ring section rearwardly engaging the forward ends of the nozzle flaps while simultaneously rotating the nozzle flaps. Means are also provided for translating the variable portion apart from the fixed portion so as to provide an opening therebetween for the admission of reverse airflow.

DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims distinctly claiming and particularly pointing out the invention described herein, it is believed that the invention will be more readily understood by reference to the discussion below and the accompanying drawings in which:

FIG. **1** is a side view of a turbofan engine and its associated aircraft structure.

FIG. **2** is a partial cross-sectional view of the cowling around the fan portion of the turbofan engine of FIG. **1.**

FIG. **2A** is a cross-sectional view taken across the lines **2a—2a** of FIG. **2.**

FIG. **3** is a partial cross-sectional view taken across the lines **3—3** of FIG. **2.**

FIG. **4** is a partial cross-sectional view of the cowling of FIG. **2** in a different mode of operation.

FIG. **5** is a partial cross-sectional view of the cowling of FIG. **2** in still another mode of operation.

FIG. **6** is a cross-sectional view taken across the lines **6—6** of FIG. **1** showing an alternate embodiment thereof.

FIG. **7** is a cross-sectional view taken across the lines **7—7** of FIG. **6.**

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. **1,** there is shown an aircraft structure such as a wing **10** which supports a turbofan engine **12,** having a concentric front fan **22** of the variable pitch type wherein the engine is supported by means of a conventional strut or pylon structure **14.** Downstream of the variable pitch fan **22** there is provided a core engine **16** which discharges a motive fluid